

THE SURGICAL FEATURES OF PERFORATION OF THE INTESTINE IN TYPHOID FEVER IN CHILDREN.¹

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IN 1898, Keen, in a monograph on the surgical complications of typhoid fever, collected eighty-three cases of typhoid perforation of the bowel which had been operated upon. In 1900 he published a paper on the same subject,¹ and reported 158 cases gathered from medical literature with 23 per cent. of recoveries. Up to March, 1903, I have found 131 additional cases, making 289 in all, with seventy-five, or 25.9 per cent., recoveries. Twenty-five of the patients were less than fifteen years of age.

During the past year I have operated upon a case of typhoid perforation of the intestine in a child of six and one-half years of age, the history of which follows:

Typhoid Fever; Intestinal Hæmorrhage; Perforation of the Intestine on the Thirty-third Day; Laparotomy and Suture of the Perforation; Recovery.—Becky H., six and one-half years of age, was admitted to the children's medical service of Dr. Koplik during the service of Dr. Heiman on July 26, 1902. The child was in the fourteenth day of a fairly severe attack of typhoid fever, with temperatures rising from 104° to 105° F. every evening, a pulse of 130 to 150, and respirations of 36 to 42. There was a well-marked Widal reaction in a dilution of 1 to 50.

On August 4, the twenty-third day of the disease, the patient had a small intestinal hæmorrhage, and at the same time developed a purulent discharge from both ears. The leucocytes varied between 7000 and 11,000.

¹ Read at the meeting of the Pædiatric Section of the New York Academy of Medicine, April 9, 1903.

On August 13, the thirty-second day of the disease, the temperature dropped in nine hours from 102.4° to 97.6° F., and the patient had several fluid blood-stained stools. At nine o'clock in the evening the patient had a severe chill followed by a rise of temperature to 104.6° F. and of the pulse to 160.

At 1 A.M. of August 14, the thirty-third day of the disease, the child complained of abdominal pain, and the abdomen was found to be slightly tender, but not rigid or distended. Leucocytes, 11,000.

At 9 A.M. the temperature had again dropped to 101.2° F. and the pulse to 148. The abdomen was found to be slightly distended; there were slight general abdominal tenderness and rigidity; the area of liver-dulness was somewhat diminished. At 2 P.M. the temperature was 99.6° F.; at 3 P.M. it was 102.4° F.; the pulse 140, and of very poor quality.

Surgical consultation at 4 P.M. The child was lying in bed with a pinched and anxious face, its thighs flexed upon the abdomen, and crying with pain. Abdomen considerably distended and fairly rigid; general abdominal tenderness most marked on the right side; liver-dulness partly obliterated; some dulness on percussion in the flanks; the child has just vomited. Temperature, 104.4° F.; pulse, 160; respiration, 40; leucocytes, 18,000. The diagnosis of perforation was concurred in and the patient transferred to the surgical service of Dr. Lilienthal for immediate operation.

5.30 P.M., chloroform anaesthesia; incision three inches long along the outer border of the right rectus muscle; peritoneal cavity found to contain gas and a large quantity of cloudy, inodorous fluid. Several distended and injected loops of small intestine presented in the wound and were packed aside with gauze. A perforation in the wall of the ileum was found about twenty centimetres from the ileocaecal junction; the opening was about the size of a pin's head, and thin yellow faecal matter was oozing from it. The perforation was closed by a double layer of Lembert sutures passed in the long axis of the bowel. As no other perforations were found, the peritoneal cavity was sponged out as thoroughly as possible and the abdominal wound closed with through-and-through sutures of silkworm gut, a small drain having been inserted in the lower angle. Duration of the operation, eleven minutes.

At the completion of the operation the pulse was 200 and

hardly perceptible; after energetic stimulation it dropped to 180, and improved in quality.

August 15. Temperature, 100.4° to 104.4° F.; respiration, 40 to 28; pulse, 160 to 140; general condition poor; delirium; some vomiting; small quantity of gas expelled after enema.

16th. Temperature, 99.6° to 102.6° F.; respiration, 30 to 28; pulse, 148 to 138; no vomiting; pulse improved in quality.

17th. Large furuncle on left hand incised; no vomiting; abdomen soft and hardly tender; fluid nourishment taken well.

19th. Profuse discharge of pus containing staphylococcus aureus from both ears; scalp shaved and numerous abscesses on scalp opened; abdominal wound has healed by primary union except for drainage opening; drain and some of the sutures removed; leucocytes, 9000.

August 27. For the past week the temperature has fluctuated between 98.6° and 102.6° F.; the pulse between 110 and 130; the respirations between 26 and 30. All abdominal symptoms have disappeared; the abdomen is soft and not tender; the bowels have moved regularly; large quantities of fluid nourishment have been taken.

On the 21st several new abscesses on the scalp and on the 27th a large abscess in the left axilla were opened. The pus from the various abscesses contained the staphylococcus aureus in pure culture.

August 29. General condition good; temperature, pulse, and respiration practically normal; leucocytes, 9000; profuse vaginal discharge containing the bacillus typhosus in pure culture (Dr. Bernstein); discharge from ears has ceased after appropriate treatment; patient has gained considerable flesh and strength.

September 2. Temperature, 98.4° to 100.2° F.; respiration, 22 to 28; pulse, 106 to 120; vaginal discharge has ceased entirely after boric acid douches; abdominal wound firmly healed. The patient was retransferred to the children's service, from which she was discharged cured about two weeks later.

The entire credit for the early recognition of the perforation is due to Dr. Heiman, and to the house physician, Dr. M. Gershel, who studied every symptom with the most scrupulous care. The case presents a few special features of interest.

The child is the youngest on record that has been operated on for typhoid perforation. We have been unable to find the record of any case of vaginal discharge which contained the typhoid bacillus in pure culture, and I consider the case in this respect a unique one. The infection was probably derived from the rectum, perhaps from the thermometer.

The following notes have been kindly furnished me by Dr. E. Bernstein, assistant in the pathological laboratory of Mt. Sinai Hospital, who isolated the typhoid bacillus from the vaginal discharge in the patient. "While the number of cases of infection due to the typhoid bacillus in the male genital organs is comparatively large, the number of such affections in the female is surprisingly small. Particularly is this true of the external genitals.

"Typhoid infections of the uterus have been reported by Blumer,⁵² Dobbin,⁵³ and two cases by Lartigau.⁵⁴ Richardson⁵⁵ gives an account of two cases of abortion in typhoid patients, in which he isolated the typhoid bacillus from the placenta, and from the liver, kidneys, and heart of the fetuses. Williams⁵⁶ succeeded in establishing the presence of the Eberth bacillus in the lochia of a typhoid patient suffering from puerperal sepsis.

"Of ovarian infections the number is still smaller, all being ovarian cysts infected by the typhoid bacillus. Thus, Werth,⁵⁷ Sudeck,⁵⁸ Pitha,⁵⁹ and Wallgren,⁶⁰ each report such a case. Unfortunately, Mabitt's⁶¹ case of typhoidal pyosalpinx was not controlled by bacteriologic examinations, and therefore cannot be considered.

"Lartigau⁶² gives a very interesting description of a young girl suffering from typhoid fever, who developed multiple ulcers on the vulva and vagina due to this bacillus, while Takaki and Werner⁶³ report a case of post-typhoidal abscess of the Bartholinian gland, from the pus of which pure typhoid bacilli were obtained.

"Our case is unique in being a pure typhoidal vaginitis, without ulceration or abscess formation. The typhoid bacillus was obtained in pure culture from the vaginal discharge, and corresponded in all respects—both in culture and agglutination characteristics—to the Eberth bacillus."

According to the reports to be found in medical literature, there seems to be a wide diversity of opinion regarding the frequency of typhoid perforation of the intestine in children. Morse² did not see a single case among 284 children with typhoid fever (7.7 per cent. of the entire number of cases of typhoid fever) at the Boston City Hospital, while Fitz³ saw seven among 192 children with this disease (3.6 per cent.). Among 1028 cases of typhoid fever in children collected by Holt⁴ perforation of the intestine occurred twelve times (1.1 per cent.). Of 232 cases of typhoid perforation collected by Barthé and Rilliet⁷ only three occurred in children. Among 289 cases of laparotomy for typhoid perforation gathered by the writer, twenty-five, or 8.6 per cent., were in children under fifteen years of age. If we combine the numbers given by Morse, Fitz, and Holt, we obtain 1504 cases with twelve, or 1.2 per cent. of perforations, and if we compare these figures with those for adults (perforation occurs in 1-2½ per cent. of all cases of typhoid fever according to most authors), we see that the frequency of this complication in the young is not far behind that in adults. With due consideration of the variations in the severity of the disease in different countries and in different epidemics, we must conclude that perforation is not so very rare in childhood, certainly not as infrequent as has been claimed by some authors (Hench,⁵ Baginsky,⁶ Morse,⁸ etc.), and that therefore severe forms of the disease are more frequent than is generally believed.

Writers on the diseases of children agree that most cases of typhoid fever in the young run a very mild course. The disease is usually of shorter duration, the intestinal lesions are often not as well marked, and ulceration is frequently absent.

In children, the pulse-rate is usually high during the entire course of the disease. According to Osler,¹¹ the abdomen is more apt to be distended in the young, though generally only in a moderate degree. Osler states that relapses are more likely in children, and that they more frequently complain of

abdominal pain. It is well known, also, that nervous manifestations are very frequent.

The writers from Johns Hopkins Hospital (Osler,¹² Finney,¹³ Cushing,¹⁴ McRae and Mitchell¹⁵) and others (Shattuck, Warren, and Cobb,¹⁶ etc.), who have made careful studies of the early symptoms of perforation, believe that the attempt should always be made to distinguish between the symptoms of perforation and those of the resulting peritonitis. In many, if not most, cases this distinction cannot be made. The only symptoms of *perforation per se* that we could conceive of, are sudden pain and perhaps sudden abdominal distention and collapse. In the majority of cases, the diagnosis of perforation is mainly made from the symptoms and signs of a sudden affection of the peritoneal cavity itself, that is of a beginning peritonitis.

It is seldom possible to make a diagnosis of impending perforation with sufficient certainty to justify operative interference in this stage (the so-called preperforative stage of Cushing⁹). When such symptoms are present, it must almost always be impossible to differentiate a preperforative stage from an early stage of perforation.

In what follows I shall make no distinction between the symptoms that might be directly due to the perforative lesion of the bowel and those of the early changes in the peritoneal cavity. Nor will the attempt be made to give a full description of the symptoms of perforation in children, which are in most respects similar to those described in adults. Mention will be made of only a few features in which the symptoms in the young differ somewhat from those in more advanced age.

Age.—Of the twenty-five patients operated upon, fourteen were between nine and twelve years of age. The ages of the patients follow: six and a half years, one; seven years, two; eight years, three; nine years, four; ten years, four; eleven years, three; twelve years, three; thirteen years, three; fourteen years, two; fifteen years, one.

Sex.—Eighteen of the patients were of the male sex, six were females, and in one patient the sex was not given. This

predominance of the male sex in childhood is of interest. Of the 158 cases of laparotomy for typhoid perforation collected by Keen,¹⁷ 84 per cent. occurred in males. According to Osler,¹⁸ males and females are about equally susceptible to typhoid fever, but male patients are more often admitted to hospitals. As most of the statistics are collected from hospitals, the predominance of perforation among the males can be partly, but not altogether, explained by the greater frequency that males apply to hospitals for treatment. The fact that 72 per cent. of the children with perforation were of the male sex cannot, however, be explained on the same basis.

General Symptoms.—Facies.—A decided change in the appearance of the face was noted in eleven of the twenty-five patients. In three, the facial appearance of the child remained unchanged for a considerable time after the appearance of other symptoms suggestive of perforation of the intestine. In ten patients no mention of the facies is made. The expression is described as pinched, anxious, collapsed. The change in the facial appearance never occurred early; it was usually observed after a number of other symptoms had directed attention to the possibility of perforation.

The primary shock of perforation is less evident in children than in adults. Children seldom show the sudden symptoms of collapse that are so frequent in adults. The pinched, anxious, collapsed appearance of the face appears only with the increasing infection of the peritoneum, and has only a proportionate value as a symptom of peritonitis.

Temperature.—In most of the cases the temperature curve showed nothing characteristic. The temperature either remained high or there were marked fluctuations. In four patients there was a sudden fall of temperature to the normal or subnormal at or soon after the perforation. Two of the patients had an intestinal hæmorrhage just before the rupture of the bowel, so that the fall in the temperature was possibly due to the bleeding from the intestine.

Pulse.—In fifteen of the twenty-five cases, the pulse is described as having become more rapid and of poorer quality

very soon after the occurrence of the perforation. In five patients the change was said to have been a sudden one at the time of perforation. In one patient (Case IX) there was no change in the character and frequency of the pulse between the time of perforation and the operation.

Respiration.—The changes in the frequency of the respiration were insignificant in all the patients until well-marked symptoms of peritonitis had developed.

Vomiting was present as an early symptom in only four patients. The longer, however, the delay in the operative interference, the more often did vomiting appear. In several patients there was no vomiting in spite of advanced peritonitis.

Leucocytosis.—Notes of leucocyte counts are given in only five cases. In five patients frequent leucocyte counts were made, and in all five there was a sudden or gradual increase in the number of white cells. The lowest count was 9000 and the highest 28,000. The fact that in all five cases a more or less marked leucocytosis was present might be considered significant, were it not for the fact that numerous cases have been reported in which there was no perforation, although abdominal symptoms and leucocytosis were present. Thus, McRae and Mitchell (*Johns Hopkins Hospital Reports*, Vol. x, Nos. 6-9) report two cases of this kind in children of twelve years of age. In one patient the symptoms were due to abdominal distention and the leucocyte count was 9700; in the second, the abdominal symptoms followed an intestinal hæmorrhage and the leucocyte count was 12,000. Just before, and for a short time after, the perforation the number of leucocytes in the blood is probably always increased, but when infection of the peritoneal cavity begins there is a great outpouring of leucocytes into the peritoneum, and the number in the blood becomes rapidly diminished. If the leucocyte counts be made during the first period, a marked increase may be noted and may be of value as confirmative evidence, but the cases of McRae and Mitchell and others of the same kind show that the presence of a leucocytosis can be used only with circum-

spection as a diagnostic symptom, while the absence of a leucocytosis does not exclude the possibility of perforation.

Local Symptoms.—Pain.—In every case in which details are given (twenty of our series), the sudden appearance of pain is mentioned as the first symptom which called special attention to the abdomen. The pain was usually localized in the lower part of the abdomen, especially on the right side. In two patients the pain was limited to the right iliac region, in five others there was general abdominal pain. In most of the patients the pain occurred in paroxysms, in a few it was constant and varied little in degree.

Tenderness on palpation was present in every case, but there seems always to have been an appreciable interval between the first appearance of pain and the appearance of this abdominal tenderness. The abdomen was most tender in the right iliac region in six cases.

Appearance of the Abdomen.—Changes in the appearance of the abdomen were noted in all but three of the twenty-five patients. In three cases there was no abdominal distention. In nine patients there was "considerable" distention, in one patient the distention was "enormous." All the other patients had only a moderate degree of distention, no more than was often seen without perforation.

Rigidity of the abdominal muscles was more or less marked in fourteen patients.

Obliteration or well-marked diminution in the *area of liver-dulness* was noted in only five cases.

This short account of the main symptoms in the twenty-five cases of our series shows that there is no essential difference between the symptoms of perforation in children and in adults. Sudden pain or increase of the existing pain is generally the earliest and most prominent symptom, perhaps with abdominal tenderness and rigidity. Changes in the temperature and pulse, leucocytosis, vomiting, diminution in the area of liver-dulness, etc., have in most cases only confirmatory value. The collapsed appearance which is presented by many adults with typhoid perforation is rarely seen in children ex-

cept in the presence of advanced peritonitis. As a moderate amount of tympanites is more apt to be present during the entire course of the fever in the young, a slight increase in the distention may occur at any time without having any significance, and with this there may be a diminution of the area of liver-dulness due solely to the distention. In most cases it is not one or the other symptom, but the *ensemble* of symptoms which must lead to the diagnosis. When, in addition to the facts that have been mentioned above, we remember that children are not as well able to describe or localize their symptoms, it will be easily understood why the diagnosis of perforation is often exceedingly difficult, and why in children errors in diagnosis may the more easily occur.

A considerable number of cases have been reported which presented the so-called characteristic symptoms of perforative peritonitis but recovered without operation, and not a few cases have been published in which laparotomy was done and a peritonitis, but no perforation found. Peritonitis may occur with deep ulceration of the bowel and changes in the serous coat, but without perforation or other discoverable abdominal lesion. Cases of this kind have been reported by Cushing,¹⁰ Finney,²⁰ McRae and Mitchell,²¹ Herringham and Bowlby,²² and others. On the other hand, it cannot be denied (as was done by Henoch²³) that after typhoid perforation of the intestine recovery may take place without operation. The opening in the bowel may become closed by fibrin, by adhesions of omentum or other coils of intestine, or a localized abscess may form and be discharged through the bowel. Fitz,²⁴ Keen, and Murchison believed that 5 per cent. of the patients with perforation of the intestine in typhoid fever recover without operation. Fitz, however, says that "since suggestive, even so-called, characteristic symptoms may occur without any perforation having taken place, it must be admitted that recovery from such symptoms is no satisfactory evidence of recovery from perforation." Notwithstanding the obvious truth of the foregoing statement, it is certainly possible that recovery may take place without operation. During the past year the writer

had occasion to see a child that presented all of the characteristic symptoms of perforation in typhoid fever, in which permission for operation was refused, and which recovered without operation. For the kind permission to make use of the records of this case I am indebted to Dr. H. Koplik, Attending Physician to the Children's Service of Mount Sinai Hospital. The history of the case follows:

H. R., male, twelve years of age, was admitted to Mount Sinai Hospital on the children's service of Dr. Koplik on October 2, 1902. The boy was in the eleventh day of his typhoid fever, with a temperature of 103.8° F., a pulse of 106, and respirations of 26. The spleen was enlarged to percussion and palpation, the abdomen was slightly distended and tender. Leucocytes, 5000. There was a well marked Widal reaction in a dilution of 1 to 50.

For four weeks the disease ran the course of an attack of typhoid fever of a fair degree of severity. The temperature began to fall after the second week, and by October 24 reached the normal, or near the normal, every morning. Slight abdominal distention, tenderness, and rigidity persisted, but with the fall of the temperature became less marked. The leucocyte count varied between 6400 and 7000.

November 4. Forty-third day of the disease; child does not look as well as usual this morning.

November 4, 4 P.M. Temperature, 100.2° F.; pulse, 104; patient complains of severe abdominal pain, most marked in the umbilical region. The abdomen is generally tender, but the tenderness is most marked in the right iliac region; the abdomen is slightly distended, and the muscles are more rigid than they have been; leucocytes, 14,000.

4.30 P.M. The patient has vomited several times.

6 P.M. Temperature, 102° F.; pulse, 116 to 128; the abdominal pain has continued; physical examination of the abdomen is about the same as when last noted; on rectal examination, the right side of the pelvic cavity is distinctly more tender than the left; patient's general appearance is distinctly worse.

9 P.M. Temperature, 104° F.; pulse, 120 to 124; leucocytes, 13,000; patient is complaining of violent abdominal pain; liver-dulness not diminished; no dulness on percussion in the flanks.

November 5, A.M. Temperature, 103.8° F.; pulse, 124 to

130; respiration, 32; patient has not vomited for the past eighteen hours; abdominal pain persists with unabated severity; liver-dulness somewhat diminished; distention of abdomen slightly increased; right iliac fossa very tender on palpation; abdominal muscles very rigid.

3 P.M. Temperature and pulse still high; abdominal pain persists; area of liver-dulness considerably diminished; abdominal distention much more marked; entire abdomen extremely tender to palpation and percussion; slight dulness on percussion in both flanks; patient looks very badly and is somewhat cyanosed. At this time the patient was seen by Dr. Lilienthal, attending surgeon in consultation with Dr. Koplik. The diagnosis of perforation of the intestine was concurred in and immediate operation recommended, but permission for the operation was refused by the child's parents.

November 6, A.M. General condition poor; temperature, 104° F.; pulse, 140; heart sounds weak; abdomen more distended and very tender to percussion and palpation.

November 7. In the morning the patient still complained of much abdominal pain and the physical signs in the abdomen were unchanged. The patient had several voluntary fluid movements of the bowels. No vomiting. In the afternoon the pulse became less rapid and of better quality, and the abdomen was distinctly less tender and rigid and less distended. The tenderness was now most marked in the right iliac region, where there was a small area of localized dulness on percussion; leucocytes, 5800.

In the evening the abdomen was very much less tender and the patient's general condition very much improved; the temperature had dropped to 98° F. and the pulse to between 80 and 90.

November 8. Temperature, 98° to 100° F.; pulse, 70 to 86; respiration, 24 to 26; patient's condition is fairly good; he looks much better; the abdominal signs are very much less marked; there is now only slight tenderness in the right iliac region; pain is no longer complained of.

After this time the course of the disease presented nothing of special interest. For several weeks the leucocyte counts varied between 7000 and 13,000. All of the abdominal symptoms rapidly disappeared and convalescence was well established by December 1.

The patient was discharged cured on December 10.

In the opinion of every one who saw this patient, he presented all of the so-called characteristic symptoms of a sudden perforation of the intestine in the course of typhoid fever, and he would surely have been operated upon if permission for the laparotomy had been obtained. Every symptom and sign characteristic of perforation—marked abdominal pain, tenderness and rigidity, distention, diminution in the area of liver-dulness, dulness on percussion in the flanks, changed appearance of the face, rapid, poor pulse, vomiting, leucocytosis—were present. Although we must acknowledge that the only certain proof of perforation of the bowel would have been the demonstration of the same at an operation, we cannot but feel justified in considering the case one of perforation, and recovery without operation, on account of the presence of every symptom and sign which are considered typical and characteristic of perforation. It is possible that the case was one of perforation of an ulcer of the appendix—that is, of so-called typhoid appendicitis,—an affection in which the tendency to localization of the process and spontaneous resolution is much greater than in perforation of the small intestine.

Time of Perforation.—The perforation occurred during the first week in no cases; second week, in 2 cases; third week, in 10 cases; fourth week, in 2 cases; fifth week, in 3 cases; sixth week, in 3 cases; a relapse in 4 cases; (?) in 1 case.

Perforation took place, therefore, most often during the third week and during a relapse. One of the cases noted above as having occurred during the third week was reported as having taken place "some time during the second or third week."¹⁰ While the physician who treats a case of typhoid fever in a child should always be on the lookout for abdominal symptoms, it is more especially during the third week of the disease and during a relapse that this abdominal complication is apt to occur. The abdomen should be frequently examined, and even the seemingly most trivial changes noted. If there has been diarrhoea or well-marked tympanites throughout the disease, or if the patient has had an intestinal hæmorrhage, no matter how small in amount, there is a much greater chance

of perforation. The conditions just mentioned are more apt to occur with deep ulceration of the bowel, and their presence is generally an evidence of the severity of the intestinal lesions.

The Time of Operation.—The shortest interval between the first symptoms of perforation and the operation was two hours (Case XX); the longest, nine days (Case XVI).

The operation was performed during the first 4 hours in 2 cases, 2 recoveries, 100 per cent recoveries; during the second 4 hours in 3 cases, 2 recoveries, 66.7 per cent. recoveries; during the third 4 hours in 7 cases, 5 recoveries, 71.4 per cent. recoveries; during the fourth 4 hours in 3 cases, 3 recoveries, 100 per cent. recoveries; during the fifth 4 hours in 1 case, 0 recoveries, 0 per cent. recoveries; during the sixth 4 hours in 1 case, 0 recoveries, 0 per cent. recoveries; later than first 24 hours in 7 cases, 4 recoveries, 57 per cent. recoveries; (?) in 1 case, 0 recoveries, 0 per cent. recoveries.

The Prognosis in Children.—While a statistical table of twenty-five cases is a small one from which to draw any sweeping conclusions, the above table does seem to indicate that very early operative interference offers the best chance for recovery. Two patients operated upon during the first four hours recovered. One patient, among three who were operated on during the second four hours after the first symptoms of perforation, recovered from the operation and from all of the abdominal symptoms, but died one week later from typhoid toxæmia (Case XXI). If this case be considered an operative recovery, then all five cases operated on during the first eight hours recovered, and of fifteen patients operated on within the first sixteen hours, thirteen, or 86.6 per cent., recovered. Of nine patients operated upon after the first sixteen hours had elapsed, only four, or 44.4 per cent., recovered.

Keen, Loison,²⁵ and others have made some allusion to the fact that after operative interference for typhoid perforation, the prognosis is more favorable in children than in adults, but comparative statistics have never yet been made. The operative reports of different surgeons show that children

recover more often than adults. Thus, Taylor²⁶ operated upon five patients,—four adults and one child,—and only the child recovered; Dalziel²⁷ operated on five adults and one child, and only the child recovered; Escher²⁸ operated upon two children and two adults, both children and one adult recovered. Among the 289 operations for typhoid perforation of the intestine collected by the writer, twenty-five were in children with sixteen, or 64 per cent., recoveries. The statistics are the following:

Total number of cases operated on, 289.

Total number of patients recovered, 75; 25.9 per cent.

Total number of patients died, 214; 74.1 per cent.

Total number of adults, 264; 91.4 per cent.

Total number of children, 25; 8.6 per cent.

Total number of adults recovered, 59; 22.4 per cent. of the adults.

Total number of adults died, 205; 77.6 per cent. of the adults.

Total number of children recovered, 16; 64.0 per cent. of the children.

Total number of children died, 9; 36.0 per cent. of the children.

Therefore, twenty-five, or 8.6 per cent. of the operations that have been performed, were in children, with a mortality of only 36 per cent., while 264, or 91.4 per cent. of the total number of operations, were done in adults with a mortality of 77.6 per cent. The chances of recovery are therefore more than twice as good in children as in adults.

These statistics show that the prognosis after operations for typhoid perforation in children is far better than has been believed heretofore. As good results as the above can surely never be obtained by medical treatment alone, or by delay in operative interference with the hope that or until the inflammatory process has become localized. The treatment of perforation of the intestine—no matter from what cause—will in all probability always retain its surgical character; and I doubt that perforation of the bowel in the course of typhoid fever will

be an exception to this rule. Surgically speaking, we believe with Cushing that the only positive contraindication to the operation is a moribund condition of the patient. Much depends upon an early diagnosis, and further improvement in operative results will surely follow advances in diagnostic methods.

Operation.—The most important point to be kept in mind in the consideration of the operative methods for typhoid perforation is that rapidity is necessary for successful results. Children bear operations upon the abdomen as well as, if not better than, adults, if the manipulations be not too much prolonged. Mauger²⁰ declares that a laparotomy for typhoid perforation should never take more time than thirty minutes, and that the operation should never be undertaken by any one who is not sure of his technique. Although some patients have recovered after operations which lasted for one hour or over, it is nevertheless true that every increase in the duration of the operation diminishes by considerable the chances of recovery of the patient. As an example of what some children with typhoid perforation are able to withstand, we might cite the case reported by Cushing (Case XIII) in which the patient was operated on three times within two weeks—twice for perforations and the third time for intestinal obstruction from adhesions—and recovered.

Regarding the technical details of the operation in children, little need be said, as the operative measures are the same as for adults. I believe, however, that a light chloroform anæsthesia is preferable to local anæsthesia in children. Aside from the difficulty of keeping children quiet during operations under local anæsthesia, my experience in other abdominal operations in children has led me to believe that in children there is less danger of shock after operations under chloroform than under local anæsthesia, no matter how much morphine the patient has received before the operation.

The abdominal incision should preferably be made along the outer border of the right rectus muscle (Kammerer) or through its fibres, as in most cases the lesion will be found on

the right side of the abdominal cavity. In children, the greater part of the peritoneal cavity can often be examined through this incision.

In children, the infiltration of the wall of the bowel around the perforation is seldom so extensive as to prevent the closure of the opening in the intestine by a double layer of Lembert sutures. These had best be passed in the long axis of the bowel, so that, when tied, they will cause a minimum amount of constriction of the intestinal lumen. If the perforation be so large or the infiltration of the wall of the bowel so extensive that simple suture is impossible, the best procedure will be an omentoplasty. A portion of the omentum is sewed over the opening in the bowel, and escape of intestinal contents thus prevented. Resection of the intestine should never be done if it can possibly be avoided; very few patients would bear the additional shock of an intestinal resection. Resection of the bowel for typhoid perforation has, however, once been performed in a child with recovery (Case II).

Escher³⁰ has recently recommended that the perforation in the bowel wall should not be sutured, but that the affected loop of intestine should be sewn to the edges of the incision in the abdominal wall and the bowel drained. Of four patients operated on by this method three recovered. Escher claims three advantages for his method: (1) the rapidity with which the operation can be done; (2) the prevention of paralytic ileus by drainage of the intestine; (3) favorable effect upon the peritonitis of drainage of the intestine. I do not believe that the first advantage claimed by Escher is of importance. The difference in the length of time that is required for the suture of a perforation and for the attachment of a loop of the bowel to the abdominal wall will in most cases be a very small one. The beneficial effects of drainage of the intestine upon paralytic ileus and peritonitis cannot, however, be denied. I believe that this method of treatment proposed by Escher merits serious consideration. It is well worthy of a trial in an appropriate case where the perforation is of large size and situ-

ated low down in the ileum, and where there is already present an advanced stage of peritonitis.

In the majority of cases (82.6 per cent., Loison³¹) there is only one perforation, but a careful search for other perforations should always be made. Monod and Vauverts³² state that it is sufficient to examine the intestine for a distance of fifty centimetres above the location of the perforation, but at least three to four feet of the ileum and in some cases the ascending colon and appendix vermiformis should be examined.

Whether the peritoneal cavity should be washed out with saline solution or not is a question whose answer must be left to the individual operator, who will be guided by his own views on the subject of irrigation of the peritoneal cavity in diffuse peritonitis. My own experience in abdominal surgery in children has been that unless there is distinctly faecal matter in the peritoneal cavity, the peritoneum will take care of itself and irrigation be unnecessary. Up to the present time very few reports of the bacteriological findings in peritonitis after typhoid perforation have been published, but it is highly probable that, from the clinical stand-point at least, the peritonitis does not differ essentially from the peritonitis that follows perforation of the bowel in other diseases. I prefer to sponge away as much as possible of the exudate with gauze sponges and to depend to a great extent upon the absorptive powers of the peritoneum. Where, however, there is faecal matter in the abdominal cavity, irrigation with isotonic 0.9 per cent. saline solution is necessary. Great care should be taken to keep the intestines as much within the abdominal cavity as possible, for the shock of evisceration in children is very great.

Neither do I think there is any advantage in a wide drainage of the peritoneal cavity. It will generally suffice to pass a small strip of gauze or a cigarette drain down to the suture line in the intestine and then to close the greater part of the abdominal incision. In the large number of cases of perforative appendicitis with diffuse peritonitis that we see at Mount Sinai Hospital every year, we rarely attempt to drain the general peritoneal cavity widely, because we do not believe that

a wide drainage of the peritoneal cavity can often be accomplished. Within a few hours of the insertion of the drains the general cavity becomes walled off by adhesions around the drains. From the time that we stopped draining the peritoneal cavity widely, or rather making the attempt to do so, our results in peritonitis have become distinctly better (see Mount Sinai Hospital Reports, Vol. iii, report of the Second Surgical Division of Dr. Howard Lilienthal).

The after-treatment differs in no way from that after laparotomy for other conditions, with the exception that the general feeding must be that of a patient with typhoid fever.

CONCLUSIONS.

Although the writer is well aware of the fallibility of statistics,—successes being more often published than failures,—the chances of error are much less where comparative statistics are given. Although it is very probable that the mortality after laparotomy for typhoid perforation is somewhat greater than the statistics show, there is no reason to doubt that the prognosis in children is fairly good,—more than again as good as in adults.

The figures given in this paper refer to children between the ages of six and fifteen years, and not to younger children or infants in whom perforation is very rare, and in whom no operation for typhoid perforation of the intestine has been recorded in literature.

The advances in abdominal surgery have been so great since Mikulicz's first operation for perforation of the intestine, that the profession is to-day almost unanimous in the belief that the only treatment for perforation of the bowel in the course of typhoid fever—as soon as the diagnosis has been made—is a surgical one. It may be many years before we can hope for much improvement in the surgical methods of treatment of diffuse peritonitis. The operative results will, however, become better if the patients are referred to the surgeon more early. Improvement can therefore only come with improved methods of diagnosis. It is from this point of view

that efforts—such as that of Cushing and his suggestion of a preperforative stage—are of value. While we may not agree with Cushing as to the possibility of diagnosing the condition correctly in any more than exceptional cases, the effort is certainly one in the right direction.

In this paper the attempt has been made to show

(1) That perforation of the intestine in the course of typhoid fever is very nearly as frequent in children between the ages of six and fifteen years as in adults.

(2) The symptoms do not differ essentially from those of adults.

(3) Although recovery may, in exceptional cases, take place without operation, the treatment should be a surgical one as soon as the diagnosis has been made.

(4) The prognosis after operation is more than twice as good in children as in adults, and very early operative interference offers the best chances for recovery.

TABLE OF CASES OF LAPAROTOMY FOR TYPHOID PERFORATION IN CHILDREN.

No.	Author.	Sex.	Age.	Main Symptoms.	Day of Disease.	From First Symptom to Operation.	Leucocytes.	Result.	Remarks.
1	Alexandroff ³⁵	M.	9	Sudden pain; vomiting; rapid pulse.	35th day.	20 hours.	.....	Death, 1½ hour.	Chloroform anaesthesia; general purulent peritonitis.
2	W. Hill ³⁴	M.	13	.....	6th week.	12 hours.	.....	Recovery.	Large perforation; resection and Murphy-button anastomosis.
3	Brun ³⁵	M.	14	Sudden pain; early and continued vomiting; moderate distention; general tenderness and rigidity; rapid pulse; pinched face.	In relapse.	22 hours.	.....	Death, 7th day.	Perforation sutured; irrigation; at autopsy five other perforations; general peritonitis.
4	Léjars ³⁶	M.	11	Symptoms of peritonitis.	?	?	.....	Death.	.....
5	Hawkins and Thurston ³⁷	F.	11	Sudden pain, in attacks; general tenderness and rigidity; vomiting; no distention.	41st day.	15 hours.	.....	Recovery.	Irrigation; drainage; excision of perforation and suture; perforation in cecal wall; seropurulent fluid.
6	Dalziel ³⁸	F.	13	.....	4th week.	11 hours.	.....	Recovery.	Median incision; irrigation; drainage.
7	Finney ³⁹	M.	12	Sudden pain; distention; tenderness and rigidity; rapid pulse.	2d-3d week.	3 days.	.....	Death.	Abdominal cavity contained gas, pus, and faeces; suture of perforation; irrigation; drainage; entered hospital in extremis.
8	Martin ⁴⁰	M.	12	.....	3d week.	33 hours.	.....	Death, 16 hours post op.	General purulent peritonitis; suture of perforation; irrigation; drainage.
9	C. R. Russell ⁴¹	M.	7	Gradual onset of pain and abdominal tenderness; no distention or rigidity; vomited once.	10th day.	12 hours.	28,000	Recovery.	.....
10	Leguen ⁴²	?	10	Sudden pain in right iliac fossa, with rigidity and tenderness; small pulse.	15th day.	12 hours.	.....	Death.	.....
11	Leguen ⁴²	M.	15	Sudden pain; collapse.	20th day.	6 hours.	.....	Recovery.	Large perforation; purulent fluid in cavity; omentoplasty; drainage.

TABLE OF CASES OF LAPAROTOMY FOR TYPHOID PERFORATION IN CHILDREN.—Continued.

No.	Author.	Sex.	Age.	Main Symptoms.	Day of Disease.	From First Symptom to Operation.	Leucocytes.	Result.	Remarks.
12	A. A. Berg ⁴³	M.	7	Sudden pain in right iliac region; chills, fever, vomiting; abdominal distention; tenderness, rigidity.	2d week.	22 hours.	.....	Recovery.	Ambulatory typhoid; diffuse peritonitis; suture of small perforation; no irrigation; drainage.
13	Cushing ⁴⁴	M.	9	Colicky abdominal pain, vomiting, rapid feeble pulse, high temperature, cyanosis, abdominal tenderness.	13th day.	4 hours.	16,000	Recovery.	Suture of perforation; seropurulent fluid in general peritoneal cavity; irrigation; drainage; fecal fistula from second perforation. Twelve days later laparotomy for symptoms of perforation; none found. Two days later laparotomy for acute intestinal obstruction due to adhesions about another perforation.
14	Richards and Goodall ⁴⁵	F.	8	Very gradual onset, with abdominal pain and tenderness.	Relapse.	12 hours.	.....	Death in 4 days.	Perforation thirty inches from cecum; suture, irrigation, drainage; autopsy showed another perforation.
15	Hugh M. Taylor ⁴⁶	M.	9	Sudden colicky pain, with abdominal tenderness and rigidity on right side; some vomiting; no distention.	Relapse.	15 hours.	.....	Recovery.	Seropurulent peritonitis; perforation sutured; irrigation; drainage.
16	Pearson ⁴⁷	M.	14	Sudden abdominal pain, followed by symptoms of peritonitis.	16th day.	9 days.	.....	Recovery.	Abscess opened and drained.
17	W. L. Rodman ⁴⁸	F.	12	Sudden pain, followed by chill and collapse. Temp. dropped to 96.2° F. from 103°; later rose to 102°; marked distention and tenderness; repeated vomiting; anxious look.	5th week.	37 hours.	.....	Recovery.	Intestines distended; perforation size of end of finger; suture; irrigation; drainage.

TABLE OF CASES OF LAPAROTOMY FOR TYPHOID PERFORATION IN CHILDREN.—Continued.

No.	Author.	Sex.	Age.	Main Symptoms.	Day of Disease.	From First Symptom to Operation.	Leucocytes.	Result.	Remarks.
18	Dandridge ⁴⁹ . . .	M.	9	Sudden severe pain, with increasing distention and tenderness; obliteration of liver-dulness; pinched face; rapid, small pulse.	21st day.	3 days.	.....	Recovery.	Gas and stinking pus in peritoneal cavity; irrigation; drainage.
19	Dandridge ⁴⁹	M.	10	Vomiting first symptom; abdominal distention and tenderness.	21st day.	28 hours.	.....	Death.	Diffuse peritonitis; perforation one inch from cecum; suture; irrigation; drainage.
20	McRae and Mitchell ¹³	F.	8	Sudden pain; marked tenderness; some distention; marked rigidity; no vomiting; liver-dulness somewhat obliterated; rapid, weak pulse.	19th day.	8 hours.	11,500	Recovery.	Perforation ten centimetres from cecum; omentoplasty; irrigation; drainage.
21	McRae and Mitchell ¹³	M.	11	Sudden pain in paroxysms; later, distention, rigidity, tenderness; partial obliteration of liver-dulness.	30th day.	8 hours.	12,000	Death after one week.	Death due to toxæmia of the disease after all abdominal symptoms had disappeared.
22	Bowlby ⁵⁰	M.	10	Paroxysm of severe pain in abdomen, followed by sweating, abdominal rigidity; rapid and feeble pulse.	34th day.	2 hours.	.....	Recovery.	Gas and fluid in cavity; intestines distended; perforation two feet from valve; no irrigation; suture of perforation; drainage.
23	Escher ⁵¹	M.	13½	Sudden pain, followed by symptoms of general peritonitis.	4th week.	80 hours.	.....	Recovery.	Perforation not found; fecal fistula established.
24	Escher ⁵¹	M.	8	Sudden fall of temp. to subnormal, with distention of abdomen, tenderness, vomiting.	3d week.	10 hours.	.....	Recovery.	Perforations in lower part of ileum; diffuse purulent peritonitis; drainage of perforations; no suture.
25	Elsberg	F.	6½	Chill, followed by abdominal distention, tenderness, rigidity, pain; partial obliteration of liver-dulness; vomiting.	33d day.	16 hours.	18,000	Recovery.	Perforation twenty centimetres from valve; seropurulent peritonitis; perforation sutured; no irrigation; drainage.

CASES OF LAPAROTOMY FOR TYPHOID PERFORATION IN
ADULTS FROM JANUARY, 1900, TO MARCH, 1903.

- Woolsey, *ANNALS OF SURGERY*, 1900, p. 764, 1 death.
 Jones, *ANNALS OF SURGERY*, Vol. xxxiv, p. 177, 1 recovery.
 Cushing, *ANNALS OF SURGERY*, 1901, 1 recovery.
 Russell, *Boston Medical and Surgical Journal*, Vol. cxliv, No. 16, 1 death.
 Lower, *Cleveland Medical Gazette*, 1900, p. 321, 1 death.
 Armstrong, *Journal of the American Medical Association*, May, 31, 1902, 25 deaths, 1 recovery.
 Briggs, *American Journal of the Medical Sciences*, January, 1902, 4 deaths, 1 recovery.
 Houchard, *Bull. et Mém. de la Soc. Anat.*, April, 1899, 1 death.
 Mayer, *Pennsylvania Medical Journal*, 1900, 1 recovery.
 Dans, *Presse Médicale*, December, 1900, 1 recovery.
 Legueu, *Revue de Chirurgie*, December, 1900, 1 recovery.
 Warren, *Transactions of the American Surgical Association*, Vol. xviii, 1900, 19 deaths, 3 recoveries.
 Loison, *Revue de Chirurgie*, xxiii, 1901, 1 recovery.
 Legueu, *Revue de Chirurgie*, xxiii, 1901, 2 recoveries.
 Rochard, *Revue de Chirurgie*, xxiii, 1901, 2 deaths.
 Routier, *Revue de Chirurgie*, xxiii, 1901, 1 death.
 Shoemaker, *Medical News*, April 12, 1902, 1 death.
 Taylor, *Dublin Journal of the Medical Sciences*, January, 1901, 2 deaths.
 Loison, *Revue de Chirurgie*, 1900, p. 179: Sieur, 1 death; Mignon, 1 death; Davis, 1 death.
 Monod, *Bull. de la Soc. de Chir.*, December, 1900, 1 death.
 D'Audet, *Arch. de Méd. Militaire*, 1899, Vol. xxiv (see Loison), 2 deaths.
 Platt, *British Medical Journal*, 1899, p. 1097, 2 deaths, 1 recovery.
 Borrs, *British Medical Journal*, 1900, 1 death.
 Balance, *British Medical Journal*, 1900, 1 death.
 Deanesly, *British Medical Journal*, May 4, 1901, 1 recovery.
 Heuston, *British Medical Journal*, November 16, 1901, 1 recovery.
 Marsden, *Lancet*, June 23, 1900, 1 death.
 Godwin, *Lancet*, August 17, 1901, 1 death.
 Davis, *American Medicine*, January 18, 1902, 1 recovery.
 Willard, *ANNALS OF SURGERY*, Vol. xxix, p. 503, 1 death.
 Taylor, *Virginia Semimonthly Medical*, 1899, 4 deaths.
 Dandridge, *Cincinnati Lancet Clinic*, 1901, 1 death.
 J. C. Munro, *Boston Medical and Surgical Journal*, February 5, 1903, 14 deaths, 1 recovery.
 Ferrier, *Semaine Médicale*, 1901, No. 7, 2 deaths, 1 recovery.
 F. Tilden Brown, *ANNALS OF SURGERY*, March, 1903, 2 deaths, 1 recovery.
 Escher, *Grenzgebiet der Medizin und Chirurgie*, Vol. xi, No. 1, 1 death, 1 recovery.
 Hays, *American Medicine*, September 6, 1902, 4 deaths, 3 recoveries.
 See also *Therapeutische Monatshefte*, November and December, 1902, for additional cases.

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- ² Boston Medical and Surgical Journal, Vol. cxxxiv, No. 9, February 20, 1896.
- ³ Transactions of Association of American Physicians, 1891.
- ⁴ The Diseases of Infancy and Childhood.
- ⁵ Handbuch der Kinderkrankheiten.
- ⁶ Handbuch der Kinderkrankheiten.
- ⁷ Loc. cit.
- ⁸ Loc. cit.
- ⁹ Johns Hopkins Hospital Bulletin, 1898.
- ¹⁰ Finney, loc. cit.
- ¹¹ Nothnagel's System, American Edition, Vol. i.
- ¹² Loc. cit.
- ¹³ Johns Hopkins Hospital Reports, 1900.
- ¹⁴ Johns Hopkins Hospital Bulletin, 1898; Johns Hopkins Hospital Reports, Vol. viii.; also ANNALS OF SURGERY, May, 1901.
- ¹⁵ Johns Hopkins Hospital Reports, 1902, Vol. x, Nos. 6 to 9.
- ¹⁶ Boston Medical and Surgical Journal, Vol. cxlii, No. 26, p. 627.
- ¹⁷ Loc. cit.
- ¹⁸ Practice of Medicine.
- ¹⁹ Loc. cit.
- ²⁰ Loc. cit.
- ²¹ Loc. cit.
- ²² Medico-Chirurgical Transactions, Vol. lxxx, p. 127.
- ²³ Loc. cit.
- ²⁴ Loc. cit.
- ²⁵ Revue de Chirurgie, 1901, Vol. xxiii, p. 177.
- ²⁶ Virginia Semimonthly Medical, 1899.
- ²⁷ Cited by Keen, q. v.
- ²⁸ Mittheilungen aus dem Grenzgebiet der Medicin und Chirurgie, Vol. xi, No. 1.
- ²⁹ Thèse de Paris, 1900, Steinheil; cited by Escher, q. v.
- ³⁰ Loc. cit.
- ³¹ Loc. cit.
- ³² Revue de Chirurgie, 1897, Vol. xvii, p. 169.
- ³³ Report for 1890 of Hospital St. Olga, Moscow; cited by Keen.
- ³⁴ In "Keen, Surgical Complications of Typhoid Fever," 1898.
- ³⁵ Bull. et Mém. de la Soc. de Chir., November 22, 1897.
- ³⁶ Semaine Médicale, 1896, No. lxi, p. 487.
- ³⁷ Lancet, October 16, 1899.
- ³⁸ Cited by Keen, Journal of the American Medical Association, 1900.
- ³⁹ Loc. cit.
- ⁴⁰ University Medical Magazine, 1899, Vol. xi, p. 502.
- ⁴¹ Boston Medical and Surgical Journal, Vol. cxliv, No. 16, p. 375.
- ⁴² Cited by Lélars, Bull. et Mém. de la Soc. de Chir. de Paris, 1900, p. 1156.
- ⁴³ Medical Record, February 2, 1901; also Mount Sinai Hospital Reports, 1900.

⁴⁴ Loc. cit.

⁴⁵ Cited by Platt, *Lancet*, 1899, Vol. i, p. 508; also by Finney, loc. cit.

⁴⁶ Cited by Keen, *Journal of the American Medical Association*, 1900, loc. cit.

⁴⁷ *British Medical Journal*, 1899, Vol. i, p. 1097.

⁴⁸ *American Medicine*, November 23, 1901.

⁴⁹ *Cincinnati Lancet Clinic*, 1901, p. 577.

⁵⁰ *Lancet*, January 10, 1903.

⁵¹ *Mittheilungen aus dem Grenzgebiet der Medicin und Chirurgie*, Vol. xi, No. 1, p. 112.

⁵² *American Journal of Obstetrics*, 1899.

⁵³ *American Journal of Obstetrics*, 1898.

⁵⁴ *New York Medical Journal*, 1900.

⁵⁵ *Transactions of the Boston Society of Medical Sciences*, 1900.

⁵⁶ *Centralblatt für Gynäkologie*, 1898.

⁵⁷ *Münchener medicinische Wochenschrift*, 1893.

⁵⁸ *Münchener medicinische Wochenschrift*, 1896.

⁵⁹ *Centralblatt für Gynäkologie*, 1897.

⁶⁰ *Archiv für Gynäkologie*, 1899.

⁶¹ *Nouvelles archives d'Obstet. et de la Gynécol.*, 1893.

⁶² *Boston Medical and Surgical Journal*, 1899.

⁶³ *Zeitschrift für Hygiene*, 1898.